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JIT and CIM Programs Alter the Material Flow

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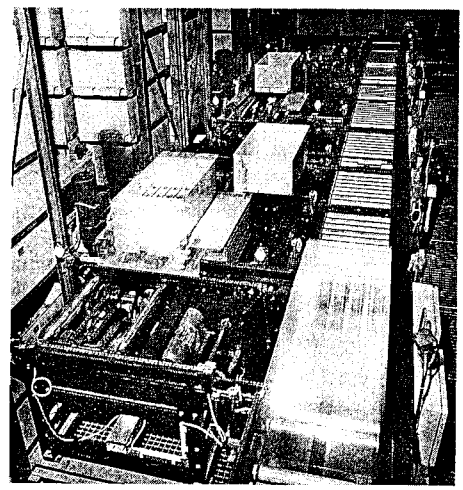
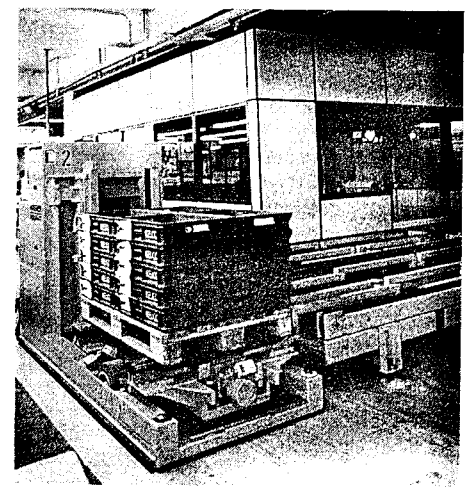
The current innovations and developments in materials handling and warehousing technology reveal one conspicuous trend: the adaptation of concepts, overriding control technologies and material handling capacities to the changing demands of the markets, i.e. in an overall form including all boundary conditions such as personnel and investments.



1: Continuous conveyors are gaining significance for handling one kind of item. With a defined transfer rate per unit of area, these conveyors are superior to all other types



2: AGV systems with a constantly growing number of variants are becoming more important by virtue of integrated additional functions such as loading or storing

Among the countless changes that have resulted from the focus of companies on sales aspects and full consideration of customer interests, a few far-reaching trends can be observed.

As regards internal procedures, the growing demand for more efficient materials handling technology is clearly one such trend. The reasons for this can be quickly found.

- The reduction of tied up capital, particularly during times of high interest rates, calls for programs to reduce inventories.
- Along with the rationalization of handling operations by means of automation, decentralized warehouses are emerging as larger units compared to previous facilities.
- Greater product diversity is aimed at gaining a larger share of the market.
- Suppliers are urged to deliver Just-in-Time because the manufacturers also have to deliver in shorter sequences.
- Consequently, manufacturing departments are organized according to modern CIM concepts targeted at a flexible and largely automated manufacturing process, even for very small batches (lot size "1").
- The course in industry is set for real growth, i.e. an increase in throughputs per unit of time.

In terms of stock-keeping, the above six trends point to declining average inventories per item. With an increasing overall throughput, a progressive rise in handling capacity will result. The consequences of this in choosing the right warehousing technology for the years until the turn of the century are not to be discussed further here. However so much is true: warehouse handling capacity will become the decisive criterion for selecting a particular system.

Consequences for Materials Handling Operations

In this area there is a trend towards smaller and lighter unit loads.

This implies that the number of mixed pallets in the palletized transport chain between companies will increase. Therefore the combined system of transport and storage unit for internal transports has to be questioned under aspects of efficiency and the pressure to operate in an economic manner.

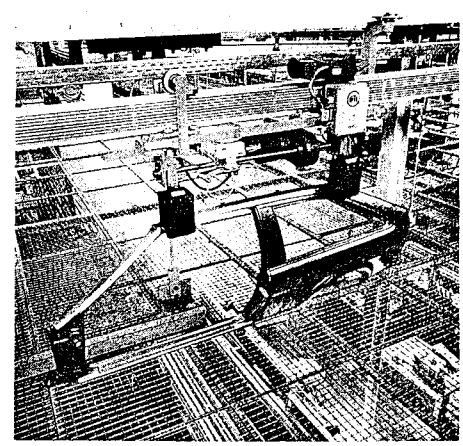
Where unit loads are moved in and out of the material flow and divided or united according to new criteria (order-picking of parts, price tagging, allocation of different parts to the same workplace in the manufacturing department etc.), continuous conveying techniques *(Fig. 1)* will regain lost ground. These systems are clearly superior to automated guided vehicle systems and overhead conveyor systems in cases where there is a "high transfer rate per unit of area".

If it is simply a matter of covering long distances from A to B in a relatively time-uncritical manner, it may be more feasible to use AGV systems *(Fig. 2)* or overhead conveyors *(Fig. 3)* instead of continuous conveyors.

This point gains further significance in the light of the growing concern about energy.

The meeting points of both operations for – ultimately – the same product involve purely intraplant palletizing and depalletizing functions. Depending on the required output, there is a further growth potential for automatic palletizers or robots in this area *(Fig. 4)*.

Besides the almost classic automation tasks of materials handling and warehous-



3: Overhead conveyors are still the most suitable means of bridging longer distances between two or several locations

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ing, further functions that were performed manually until now are gradually being automated.

For instance, with today's Just-in-Time requirements there seems to be no reason why manual identification of incoming goods should still be necessary. Genuine JIT processes can only be implemented without such inspections, i.e. without a quality control of the goods received. The supplier as partner does not supply goods of inferior quality. He receives his long-range production and short-range delivery specifications from the customer on-line.

Consequently, the customer could check that the goods delivered are on time and in the right quantity by an automatic means in the goods receiving department, for example by scanning bar code labels that are attached to the incoming items as agreed.

Progressively Increasing Transport and Warehousing Operations

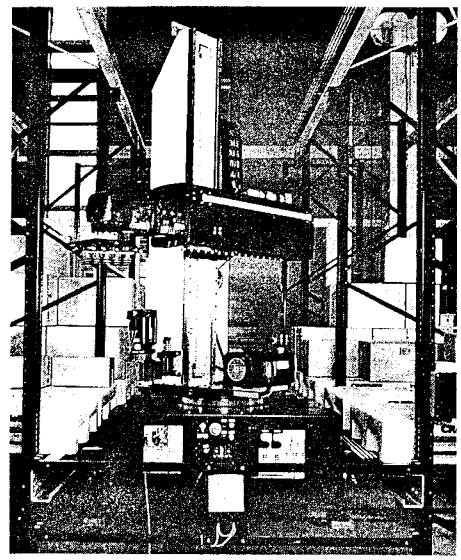
Different consequences in terms of quality can be identified in this context. If the former distribution structures are reviewed under the aspect of reduced volumes and thus smaller space requirements, and for example several of the former decentral warehouses combined as a result, the new central warehouse will naturally have higher inventories, i.e. compared to one of the former warehouses. Irrespective of the above trends, centralization – depending on the cumulating sales volumes – leads to an underproportional growth in inventories and thus to faster handling frequencies. The order picking technique analyzed below illustrates the close intertwinement of the diversified influencing variables when it comes to the flow of materials, whereby contradictory technical interests can never be entirely ruled out.

What Kind of Productivity Does Order Picking Demand

When the overall warehouse capacity is increased for the same range of articles, the picking and storage operations will be less productive – unless the existing organizational procedures and techniques are critically reviewed. Average path times increase substantially compared to the decentral system.

Regardless of the question of concentration, a decline in productivity inevitably occurs with mainly manually operated systems, simply due to the reduction of the lot sizes (or increased ordering frequency). The path times and orientation times per operation do not change. Picking times do not necessarily decrease in proportion to the reduction in the number of retrievals. However, the number of operations increases. For picking small items, a path time of roughly 20 to 30% can be assumed.

By a purely mathematical calculation this produces an increase in manpower requirements for the task in question by more than 10% should the turnover frequency of the warehouse increase, for example from 8 to 12, if this is accompanied



4: Mobile robots for picking of single parcels. Similar, stationary units for both palletizing and depalletizing tasks can also be used

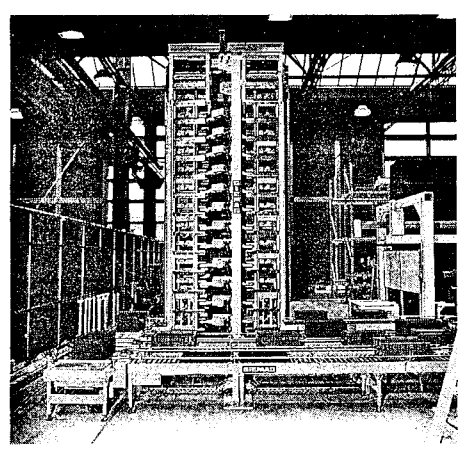
by a correspondingly higher delivery frequency to the customers, and if the saving in floor space and thus reduced path times are not taken into consideration.

Even assuming that the calculated reduction in required storage space of approximately 20% can be optimally translated into a new layout with minimum paths, there remains an additional personnel requirement of about 5%.

The above-mentioned merging of warehouses would produce – from a purely mathematical point of view and assuming that 3 identical warehouses with a turnover rate of 8 each were to be closed – a new central warehouse with an approximate reduction in volume of 40%, i.e. a turnover rate of 14 per year. The average path of a forklift driver in putting a pallet into storage would be more than tripled, even with an optimum layout. The number of transport operations for retrievals would increase by 75%.

New Structures for the Material Flow

Apart from the question as to whether the additional staff – if available at all in terms of quality and quantity – would not keep



5: New warehousing techniques for part-to-person operations – such as the Sistore – are gaining ground

stepping on each others' toes if the former structures were to be retained, a management aim must be to avoid putting an unnecessary strain on the substantial savings which are undoubtedly gained from reduced inventories (tied-up capital) and centralization (overheads) through extra personnel costs.

Even if such losses in productivity ultimately reflect only general trends that need to be reviewed in each individual case on the basis of the given planning guidelines and optimum concepts, it becomes evident that long-standing organizational procedures and techniques now have to be queried.

Where manual activities are to be retained in the foreseeable future, one should consider whether separating the spare stocks from the articles that are directly accessible for picking purposes could reduce the necessary manual paths to an acceptable level again. Naturally, the additional effort for moving the stock has to be taken into account, unless dynamic racking can be used and these tasks be accomplished automatically.

One can of course examine whether part-to-person systems in conjunction with automated warehousing techniques could completely eliminate such paths and thus produce additional savings in terms of personnel *(Fig. 5)*.

Two aspects have to be considered in this respect. First, picking tasks are usually order-related, whereby picking aids (totes, trays, pallets etc.) are supplied to the retrieval point and are loaded with the required goods; where possible this is done using computer-aided paperless instructions.

Multiple picking of items from one storage means is possible to the extent that several suitable picking aids can be stored intermediately within reach of the order picker or that the storage means can approach several retrieval points in succession via a conveyor system. Thus, complicated organizational structures with more elaborate materials handling techniques, featuring accumulation zones, branches and merging points, will result.

On the other hand, the capacity of such systems will be restricted by the efficiencies of the picking aids, of the feeding and delivery system and of the corresponding handling system for the storage means. An increasing frequency of retrievals – and smaller number of order-related items per retrieval – will make full use of the originally available reserve capacity. The former correlation between the processing operation (removal from the storage means) and subsequent supply of the next storage means gets lost – this order picking technique is also tending to become less efficient.

Greater Significance of Item-related Picking

The necessary consequence is to change from order-related (single-step) picking to item-oriented picking, i.e. in two steps. This solution would be optimal as regards the

picking paths in manual picking operations. In a computer aided part-to-person system the interdependencies of order-picking locations and the associated queues for storage and picking equipment would be immediately eliminated. The efficiency of the "warehouse machine" could be maximized in a simple manner.

So why was this technique not adopted long ago?

In terms of handling techniques, the performance limits are naturally reached at a much earlier stage if, for example, one tote is handled per order line instead of one per order, even if a slightly smaller tote can be used.

The size of the latter must be geared to the maximum dimensions of a part to be picked. In other words, the base area of each tote is hardly reduced through the smaller number of items to be handled.

In addition, the single retrievals then have to be compiled for a customer or order – possibly in a defined sequence such as heavy parts before light parts or product group-related – and consolidated into a shipping order. Manual handling in this second picking stage can ruin all gains made before in stage one.

Forward-looking Solutions

The future answer is automation of the 2nd stage using sortation techniques. The sorter itself should be designed to take on the item-related retrievals at the order-picking location (part-to-person) without additional aids.

Compared to conventional continuous conveying techniques with picking aids, this can produce a distinct increase in capacity by a maximum factor of 10.

The destination of the single sorter elements is then for example a packing station which is temporarily allocated to a certain order.

A sorter of this kind could naturally also take on items that have been compiled into part-orders from areas with a different organization (than part-to-person systems) with a view to parallel picking methods. In this case, however, picking aids would normally be used.

Consolidating orders in this way, by including for example manual picking areas with picking paths or automatic picking devices and robots for suitable items will additionally boost the efficiency of the overall system.

Should this still not be sufficient for certain applications in view of forthcoming requirements, a three-stage picking process can be adopted. The first stage would then consist of automatic discharging of the parts from a sorter into a tote. In the second stage the totes from different sorters would be collected for a specific order. Further measures to improve efficiency can naturally be elaborated.

Finally, it remains to be said that the technical feasibility outlined above has to be calculated under economic aspects. On the positive side, it can be claimed that rising costs in an expanding economy are kept under control for the foreseeable future by substituting personnel costs with investment costs. Should business deteriorate, the relatively high portion of fixed costs through the high level of automation achieved can become a bind.

In any case, the planning of materials handling and warehousing systems is gaining significance in view of constantly increasing capital investments. Oversized equipment could reduce the gain in productivity, and in extreme cases, due to apparent uneconomicalness, could stand in the way of a project that would safeguard the competitiveness of a company.

Undersized equipment can be ruinous if a company's competitiveness is clearly reduced by the serious deterioration of its logistic service.

Naturally, the systems chosen must be manageable and adapted to the situation of the respective company. In this respect the demand for qualified supervisory and control personnel will increase substantially in the future. The same applies to the team responsible for maintenance.

Future materials handling systems will be characterized by new performance categories, the increased use of multi-stage picking techniques assisted by sorters, and the employment of less, but more qualified personnel.